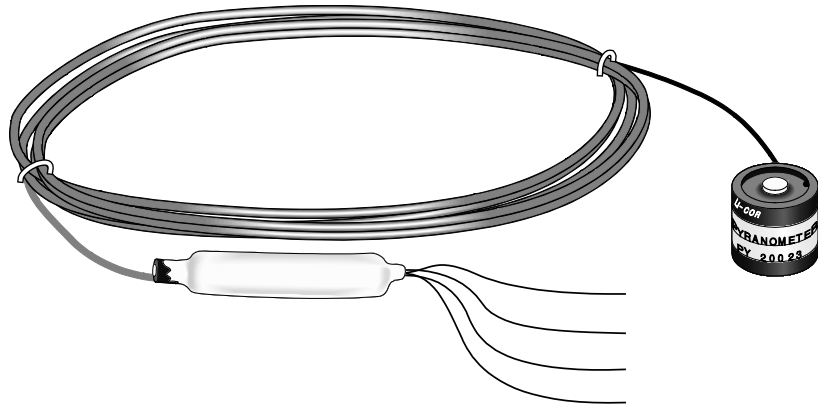


INSTRUCTION MANUAL



LI200X Pyranometer

Revision: 1/15



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Precautions

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com or by telephoning (435) 227-9000 (USA). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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LI200X Pyranometer

1. Introduction

The LI200X pyranometer monitors sun plus sky radiation. It connects directly to our dataloggers, and is used extensively in solar, agricultural, and meteorological applications.

NOTE

This manual provides information only for CRBasic dataloggers. It is also compatible with most of our retired Edlog dataloggers. For Edlog datalogger support, see an older manual at www.campbellsci.com/old-manuals or contact a Campbell Scientific application engineer for assistance.

2. Cautionary Statements

- READ AND UNDERSTAND the *Precautions* section at the front of this manual.
- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, consult with a Campbell Scientific application engineer.
- Although the LI200X is rugged, it should be handled as a precision scientific instrument.
- The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.

3. Initial Inspection

- Upon receipt of the LI200X, inspect the packaging and contents for damage. File damage claims with the shipping company.

4. Quickstart

Short Cut is an easy way to program your datalogger to measure the LI200X and assign datalogger wiring terminals. The following procedure shows using *Short Cut* to program the LI200X.

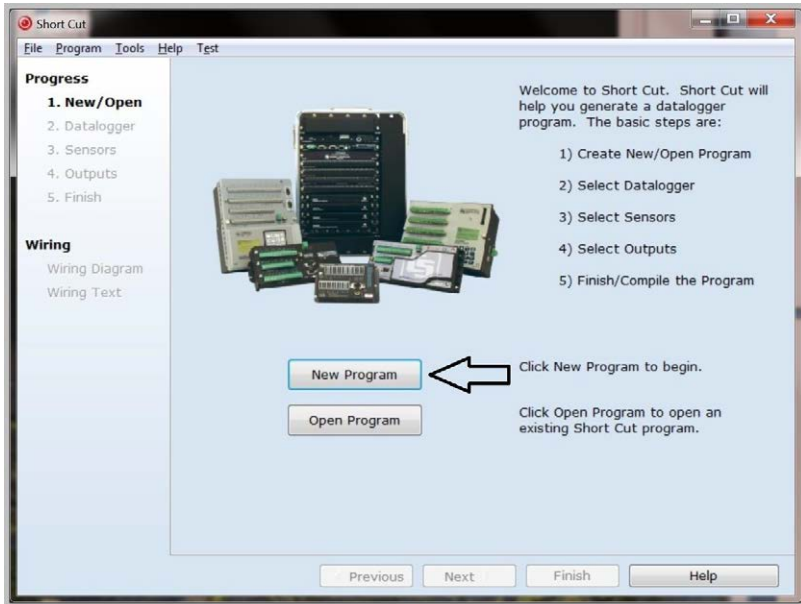
1. Install *Short Cut* by clicking on the install file icon. Get the install file from either www.campbellsci.com, the ResourceDVD, or find it in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ* software.



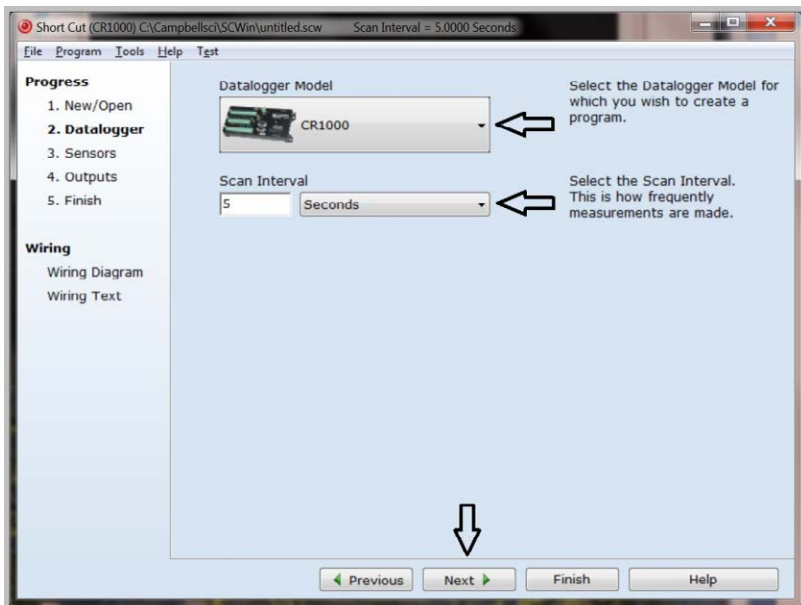
- The *Short Cut* installation should place a shortcut icon on the desktop of your computer. To open *Short Cut*, click on this icon.




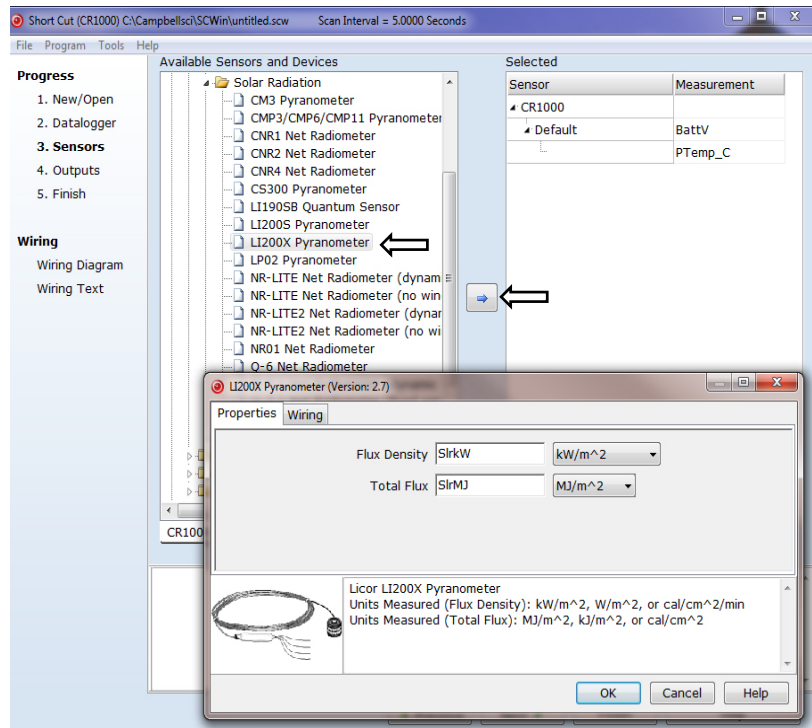
- When *Short Cut* opens, select **New Program**.



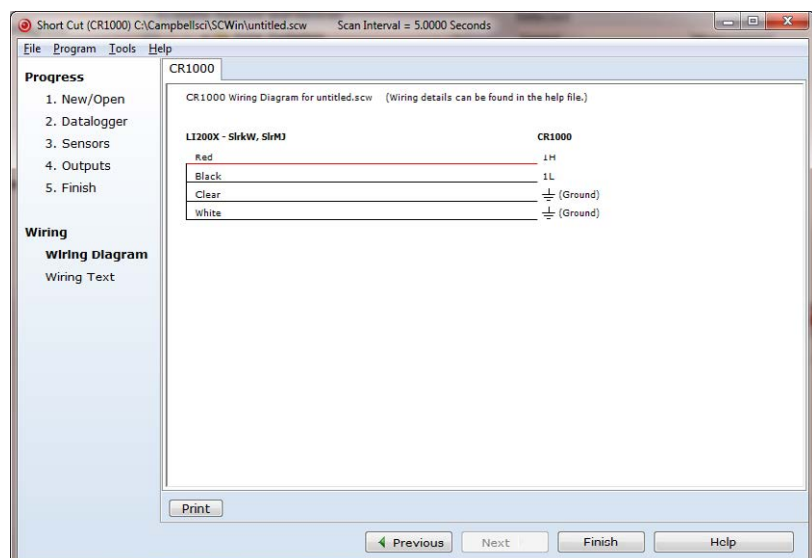
- Select **Datalogger Model** and **Scan Interval** (default of 5 seconds is OK for most applications). Click **Next**.



5. Under the **Available Sensors and Devices** list, select the **Sensors | Solar Radiation** folder. Select **LI200X Pyranometer**. Click  to move the selection to the **Selected** device window. The flux density defaults to kW/m^2 and the total flux defaults to MJ/m^2 . This can be changed by clicking the **Flux Density or Total Flux** box and selecting one of the other options.



6. After selecting the sensor, click at the left of the screen on **Wiring Diagram** to see how the sensor is to be wired to the datalogger. The wiring diagram can be printed out now or after more sensors are added.



7. Select any other sensors you have, then finish the remaining *Short Cut* steps to complete the program. The remaining steps are outlined in *Short Cut Help*, which is accessed by clicking on **Help | Contents | Programming Steps**.
8. If *LoggerNet*, *PC400*, *RTDAQ*, or *PC200W* is running on your PC, and the PC to datalogger connection is active, you can click **Finish** in *Short Cut* and you will be prompted to send the program just created to the datalogger.
9. If the sensor is connected to the datalogger, as shown in the wiring diagram in step 6, check the output of the sensor in the datalogger support software data display to make sure it is making reasonable measurements.

5. Overview

The LI200X measures incoming solar radiation with a silicon photovoltaic detector mounted in cosine-corrected head. The detector outputs current; a shunt resistor in the sensor cable converts the signal from current to voltage, allowing the LI200X to be measured directly by Campbell Scientific dataloggers.

The LI200X is calibrated against an Eppley Precision Spectral Pyranometer to accurately measure sun plus sky radiation. Do not use the LI200X under vegetation or artificial lights, because it is calibrated for the daylight spectrum (400 to 1100 nm).

During the night, the LI200X may read slightly negative incoming solar radiation. This negative signal is caused by RF noise. Negative values may be set to zero in the datalogger program.

The -L portion of the model number indicates that the LI200X has a user-specified cable length. Its cables can terminate in:

- Pigtails that connect directly to a Campbell Scientific datalogger (cable termination option -PT; see FIGURE 5-1).
- Connector that attaches to a prewired enclosure (cable termination option -PW).

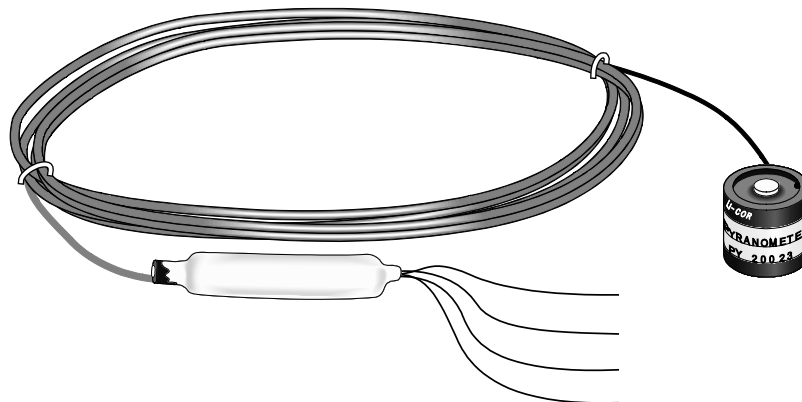


FIGURE 5-1. LI200X Pyranometer with -PT cable termination option.

For more theoretical information on the silicon photovoltaic detector see Kerr, J. P., G. W. Thurtell, and C. B. Tanner: 1967, "An integrating pyranometer for climatological observer stations and mesoscale networks", *J. Appl. Meteor.*, **6**, 688-694.

6. Specifications

Features:

- Calibrated for the daylight spectrum (400 to 1100 nm)
- Completion circuit in its cable standardizes calibration, allowing sensors to be interchanged without altering multiplier and offset values
- Compatible with Campbell Scientific CRBasic dataloggers: CR6, CR800 series, CR1000, CR3000, CR5000, and CR9000(X).

Stability: < $\pm 2\%$ change over a 1 year period

Response Time: 10 μ s

Cosine Correction: Cosine corrected up to 80°

Operating Temperature: -40 to 65 °C

Temperature Dependence: 0.15% per °C

Relative Humidity: 0 to 100%

Detector: High stability silicon photovoltaic detector (blue enhanced)

Sensor Housing: Weatherproof anodized aluminum case with acrylic diffuser and stainless steel hardware

Diameter: 2.38 cm (0.94 in)

Height: 2.54 cm (1.00 in)

Weight: 28 g (1 oz)

Accuracy: Absolute error in natural daylight is $\pm 5\%$ maximum; $\pm 3\%$ typical

Sensitivity: 0.2 kW m⁻² mV⁻¹

Linearity: Maximum deviation of 1% up to 3000 W m⁻²

Shunt Resistor: Adjustable, 40.2 to 90.2 Ω , factory set to give the above sensitivity

Light Spectrum Waveband: 400 to 1100 nm

7. Installation

If you are programming your datalogger with *Short Cut*, skip Section 7.3, *Wiring*, and Section 7.4, *Programming*. *Short Cut* does this work for you. See Section 4, *Quickstart*, for a *Short Cut* tutorial.

7.1 Siting

The LI200X should be mounted such that no shadows or reflections are cast on it by the tripod/tower or other sensors. The sensor should be mounted with the cable pointing towards the nearest magnetic pole. For example, in the Northern Hemisphere, point the cable toward the North Pole.

Mounting height is not critical for the accuracy of the measurement. However, pyranometers mounted at heights of 3 m or less are easier to level and clean.

7.2 Mounting to an Instrument Mount

7.2.1 Required Tools

Tools required for installation on a tripod or tower:

- Small and medium Phillips screwdrivers
- 1/2 in open end wrench for CM225 or 015ARM
- Tape measure
- UV-resistant cable ties
- Side-cut pliers
- Compass
- Step ladder

7.2.2 Mounting Procedure

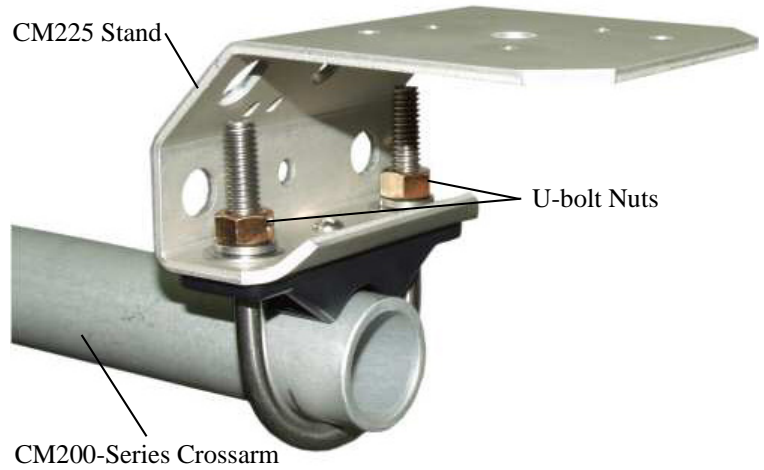
7.2.2.1 CM225 Solar Sensor Mounting Stand

CAUTION

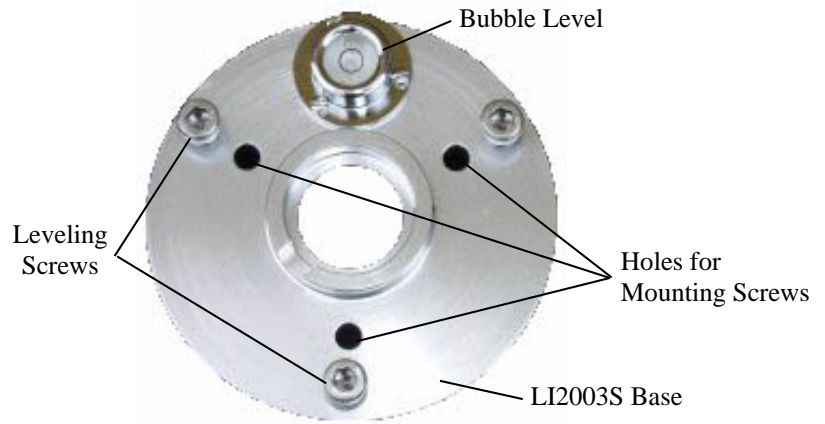
The CM225 should never be mounted directly to a vertical pipe. Instead the CM225 should be mounted to a crossarm. This avoids reflections from the vertical pipe onto the sensor.

1. Mount the crossarm to the tripod or tower.

2. Place the CM225's U-bolt in the bottom holes and secure the CM225 to the crossarm by tightening the U-bolt nuts.



3. Place the LI200X in the center of the LI2003S base/leveling fixture.



4. Loosely mount the LI2003S base/leveling fixture on the CM225. Do not fully tighten the three mounting screws.



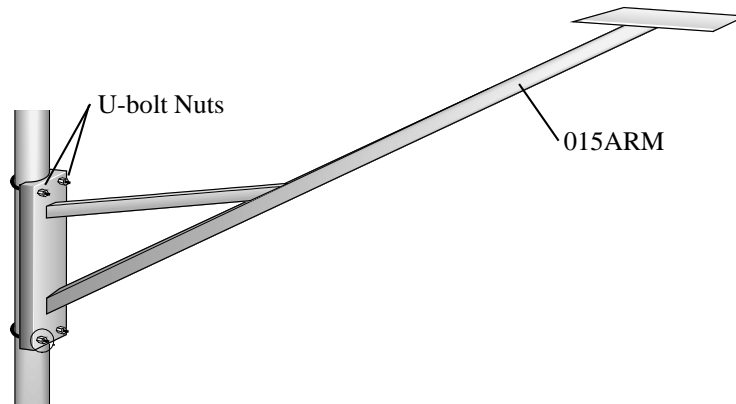
5. Turn the leveling screws as required to bring the bubble of the bubble level within the ring.



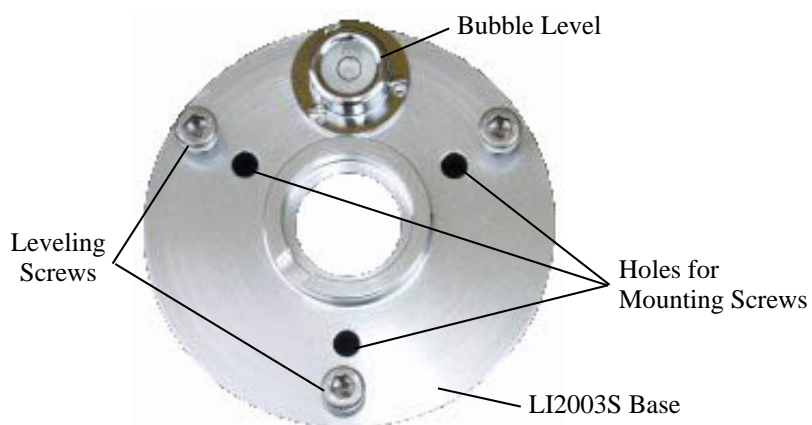
6. Tighten the mounting screws to secure the assembly in its final position. Check that the pyranometer is still correctly leveled and adjust as necessary.
7. Route the sensor cable along the underside of the crossarm to the tripod/tower, and to the instrument enclosure.
8. Secure the cable to the crossarm and mast using cable ties.
9. Remove the red cap after installing the sensor. Save this cap for shipping or storing the sensor.

7.2.2.2 015ARM

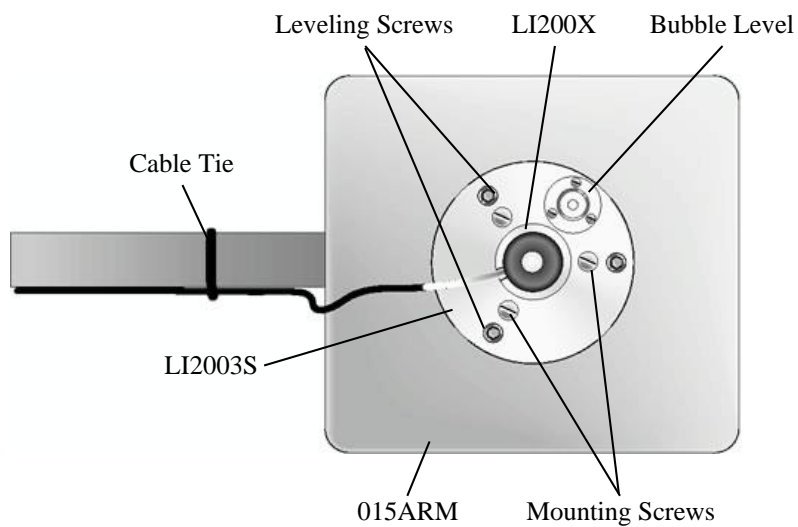
1. Secure the 015ARM to the mast by tightening the U-bolt nuts.



- Place the LI200X in the center of the LI2003S base/leveling fixture.



- Loosely mount the LI2003S base/leveling fixture on the 015ARM. Do not fully tighten the three mounting screws.



- Turn the leveling screws as required to bring the bubble of the bubble level within the ring.
- Tighten the mounting screws to secure the assembly in its final position. Check that the pyranometer is still correctly leveled and adjust as necessary.
- Route the sensor cable along the underside of the 015ARM's arm to the tripod/tower, and to the instrument enclosure.
- Secure the cable to the mounting arm and mast using cable ties.
- Remove the red cap after installing the sensor. Save this cap for shipping or storing the sensor.

7.3 Wiring

A schematic diagram of the LI200X is shown in FIGURE 7-1.

Connections to Campbell Scientific dataloggers are given in TABLE 7-1. When *Short Cut* software is used to create the datalogger program, the sensor should be wired to the channels shown in the wiring diagram created by *Short Cut*.

Color	Description	CR6, CR9000(X) CR5000, CR3000 CR1000, CR800 CR850
Red	Signal	Differential High
Black	Signal Reference	Differential Low
White	Signal Ground	⏏
Clear	Shield	⏏

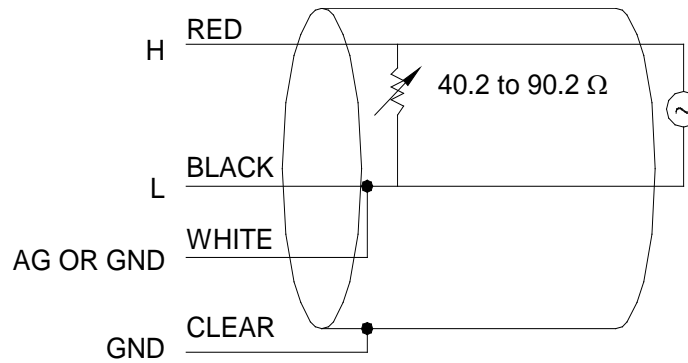


FIGURE 7-1. LI200X Schematic

7.4 Programming

Short Cut is the best source for up-to-date datalogger programming code. Programming code is needed

- when creating a program for a new datalogger installation
- when adding sensors to an existing datalogger program

If your data acquisition requirements are simple, you can probably create and maintain a datalogger program exclusively with *Short Cut*. If your data acquisition needs are more complex, the files that *Short Cut* creates are a great source for programming code to start a new program or add to an existing custom program.

NOTE

Short Cut cannot edit programs after they are imported and edited in *CRBasic Editor*.

A *Short Cut* tutorial is available in Section 4, *Quickstart*. If you wish to import *Short Cut* code into *CRBasic Editor* to create or add to a customized program, follow the procedure in Appendix A.1, *Importing Short Cut Code into a Program Editor*. Programming basics for CRBasic dataloggers are provided in the following sections. A complete program example for a CRBasic datalogger can be found in Appendix B, *Example Program*. Programming basics and programming examples for Edlog dataloggers are provided at www.campbellsci.com/old-manuals.

Output from the LI200X is $0.2 \text{ kW m}^{-2} \text{ mV}^{-1}$, which is measured by the datalogger using the VoltDiff CRBasic instruction. CRBasic is included in PC400 and LoggerNet datalogger support software.

Nearby AC power lines, electric pumps, or motors can be a source of electrical noise. If the sensor or datalogger is located in an electrically noisy environment, the measurement should be made with the 60 or 50 Hz rejection integration option as shown in the example program.

Solar radiation can be reported as an average flux density (W m^{-2}) or daily total flux density (MJ m^{-2}). The appropriate multipliers are listed in TABLE 7-2. Programming examples are given for both average and daily total solar radiation. Negative values should be set to zero before being processed.

TABLE 7-2. Multipliers Required for Average Flux and Total Flux Density in SI and English Units		
UNITS	MULTIPLIER	PROCESS
W m^{-2}	200	Average
MJ m^{-2}	$t * 0.0002$	Total
kJ m^{-2}	$t * 0.2$	Total
$\text{cal cm}^{-2} \text{ min}^{-1}$	$0.2 * (1.434)$	Average
cal cm^{-2}	$t * 0.2 * (0.0239)$	Total
t = datalogger execution interval in seconds		

7.4.1 Total Solar Radiation

If the solar radiation is totalized in units of kJ m^{-2} , there is a possibility of overranging the output limits. For CRBasic dataloggers, you can avoid this by using the IEEE4 or long data format.

8. Maintenance

On a monthly basis, the level of the pyranometer should be checked. Any dust or debris on the sensor head should be removed. The debris can be removed with a blast of compressed air or with a soft bristle, camel hair brush. Check that the drain hole next to the surface of the sensor is free of debris.

CAUTION

Handle the sensor carefully when cleaning. Be careful not to scratch the surface of the sensor.

Recalibrate the LI200X every two years. Refer to the [Assistance](#) page at the beginning of this document for the process of returning the pyranometer to Campbell Scientific, Inc. for recalibration.

9. Calibration

LI200X pyranometers output a current that is proportional to the incoming solar radiation. Each LI200X has a unique calibration factor. A variable shunt resistor in the cable converts the current to the voltage measured by the datalogger. Campbell Scientific sets the shunt resistor so that the pyranometer outputs $5 \text{ mV kW}^{-1} \text{ m}^2$.

The resistor value is found using Ohms law. The resistance is found by dividing the desired output voltage by the calibrated current output. For example, a pyranometer with a calibration of $92 \text{ } \mu\text{A kW}^{-1} \text{ m}^2$, will have the resistor set to:

$$54.35 \text{ } \Omega = 5 \text{ mV kW}^{-1} \text{ m}^2 / 0.092 \text{ mA kW}^{-1} \text{ m}^2.$$

10. Troubleshooting

Symptom: -9999 or radiation values around 0

1. Check that the sensor is wired to the Differential channel specified by the measurement instruction.
2. Verify that the Range code is correct for the datalogger type.
3. Disconnect the sensor leads from the datalogger and use a DVM to check the voltage between the red (+) and the black (-) wires. The voltage should be 0 to 5 mV for 0 to 1000 Wm^{-2} radiation. No voltage indicates a problem with the photodiode, cable, or the variable shunt resistor.

Symptom: Incorrect solar radiation

1. Make sure the top surface of the sensor head is clean, and that the sensor is properly leveled.
2. Verify that the Range code, multiplier and offset parameters are correct for the desired engineering units and datalogger type.

Appendix A. Importing Short Cut Code

This tutorial shows:

- How to import a *Short Cut* program into a program editor for additional refinement.
- How to import a wiring diagram from *Short Cut* into the comments of a custom program.

A.1 Importing Short Cut Code into a Program Editor

Short Cut creates files that can be imported into either *CRBasic Editor* or *Edlog* program editor. These files normally reside in the C:\campbellsci\SCWin folder and have the following extensions:

- .DEF (wiring and memory usage information)
- .CR6 (CR6 datalogger code)
- .CR1 (CR1000 datalogger code)
- .CR8 (CR800 datalogger code)
- .CR3 (CR3000 datalogger code)
- .CR5 (CR5000 datalogger code)

Use the following procedure to import *Short Cut* code into *CRBasic Editor* (CR6, CR1000, CR800, CR3000, CR5000 dataloggers).

1. Create the *Short Cut* program following the procedure in Section 4, *Quickstart*. Finish the program and exit *Short Cut*. Make note of the file name used when saving the *Short Cut* program.
2. Open *CRBasic Editor*.
3. Click **File | Open**. Assuming the default paths were used when *Short Cut* was installed, navigate to C:\CampbellSci\SCWin folder. The file of interest has a “.CR6”, “.CR1”, “.CR8”, “.CR3”, or “.CR5” extension, for CR6, CR1000, CR800, CR3000, or CR5000 dataloggers, respectively. Select the file and click **Open**.
4. Immediately save the file in a folder different from \Campbellsci\SCWin, or save the file with a different file name.

NOTE

Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the datalogger program. Change the name of the program file or move it, or *Short Cut* may overwrite it next time it is used.

5. The program can now be edited, saved, and sent to the datalogger.
6. Import wiring information to the program by opening the associated .DEF file. Copy and paste the section beginning with heading “-Wiring for CRXXX-” into the *CRBasic* program, usually at the head of the file. After pasting, edit the information such that a ' character (single quotation

mark) begins each line. This character instructs the datalogger compiler to ignore the line when compiling the datalogger code.

Appendix B. Example Program

The following program measures the LI200X every 10 seconds, and converts the mV output to Wm^{-2} and MJ m^{-2} . The program outputs an hourly average flux (Wm^{-2}) and a daily total flux density (MJm^{-2}). Negative values are set to zero before being processed. Wiring for the example is given in TABLE B-1.

TABLE B-1. Wiring for Example Program

Color	Description	CR1000
Red	Signal	1H
Black	Signal Reference	1L
White	Signal Ground	\perp
Clear	Shield	\perp

B.1 Example CR1000 Program

In the CR1000 example, a daily total flux density is found. This total flux density is in $\text{MJ m}^{-2} \text{day}^{-1}$. Negative values are set to zero before they are added to the running total.

```
'CR1000

'Declare Variables and Units
Public S1rW
Public S1rMJ

Units S1rW=W/m2
Units S1rMJ=MJ/m2

'Define Data Tables
DataTable(Table1,True,-1)
  DataInterval(0,60,Min,10)
  Average(1,S1rW,FP2,False)
EndTable

DataTable(Table2,True,-1)
  DataInterval(0,1440,Min,10)
  Totalize(1,S1rMJ,IEEE4,False)
EndTable

'Main Program
BeginProg
  Scan(10,Sec,1,0)

  'measure the LI200X
  VoltDiff(S1rW,1,mV7_5,1,True,0,_60Hz,1,0)      'use 20mV range for
                                                    'CR5000 and CR3000

  'set negative values to zero
  If S1rW<0 Then S1rW=0

  'convert mV to MJ/m2 for 10 second execution interval
  S1rMJ=S1rW*0.002
```

```
'convert mV to W/m2
SlrW=SlrW*200.0

'Call Data Tables and Store Data
CallTable(Table1)
CallTable(Table2)
NextScan
EndProg
```


Appendix C. LI200S Pyranometer

C.1 LI200S Pyranometer

LI200S pyranometers have a 100 ohm shunt resistor built into the cable. They can be directly measured by Campbell Scientific dataloggers. The input range and multipliers vary from one pyranometer to another. See Appendix C.3, *Input Range*, and Appendix C.4, *Multiplier*, for calculating the proper input range and multiplier.

C.1.1 Wiring

The red lead is connected to the high side (H) of a differential input channel and the black lead to the corresponding low side (L). On the CR10 a jumper wire is installed between the low side and analog ground (AG). The clear lead is connected to ground (G). On the 21X the jumper wire is installed between the low side and ground (G) and the clear lead is also connected to ground (G). The measurement is then made with Instruction 2 (see Section 7.4, *Programming*).

C.2 Unmodified Pyranometers

Pyranometers that do not have variable or fixed shunt resistors built into the cable can still be measured by Campbell Scientific dataloggers. This is done by wiring in a 100 Ω shunt resistor directly onto the datalogger wiring panel. The input range and multipliers vary from one pyranometer to another. See Appendix C.3, *Input Range*, and Appendix C.4, *Multiplier*, for calculating the proper input range and multiplier.

C.2.1 Wiring

Signal positive is connected into the high side (H) of a differential input channel and signal negative to the corresponding low side (L). A jumper wire is installed between the low side (L) and analog ground (AG) on the CR10 wiring panel or ground on the 21X. A 100 Ω 1% resistor is installed on the wiring panel between the high and low sides the measurement channel. The measurement is then made with Instruction 2 (see Section 7.4, *Programming*).

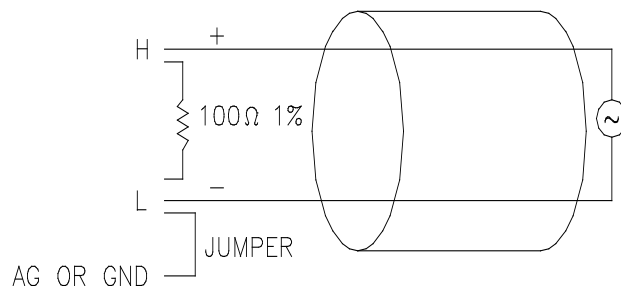


FIGURE C-1. Unmodified Pyranometer Wiring Schematic

C.3 Input Range

The following is an example of how to determine the optimum input range for a given sensor calibration and maximum expected irradiance. *This is an example only. Your values will be different.*

This example uses the calibration provided by LI-COR, Inc. Assume that the sensor calibration is $87 \mu\text{A kW}^{-1} \text{m}^2$. The pyranometer outputs current which is converted to voltage by the 100Ω shunt resistor in the cable or on the wiring panel. To convert the calibration from current to voltage, multiply the LI-COR calibration by $0.1 \text{ K}\Omega$ (shunt resistor). The example calibration changes to $8.7 \text{ mV kW}^{-1} \text{m}^2$.

A reasonable estimate of maximum of irradiance at the earth's surface is 1 kW m^{-2} . Thus, an estimate of the maximum input voltage is obtained by multiplying the calibration by the maximum expected irradiance. In this example that product is 8.7 mV . Now, select the smallest input range which is greater than the maximum expected input voltage. In this case the 25 mV slow range for the CR10 and 15 mV slow range for the 21X are selected.

C.4 Multiplier

The multiplier converts the millivolt reading to engineering units. The most common units and equations to calculate the multiplier are listed in TABLE C-1.

TABLE C-1. Multipliers Required for Average Flux and Total Flux Density for SI and English Units for a LI200S Pyranometer		
UNITS	MULTIPLIER	PROCESS
W m^{-2}	$(1/C) * 1000$	Average
MJ m^{-2}	$t * (1/C) * 0.001$	Total
kJ m^{-2}	$t * (1/C)$	Total
$\text{cal cm}^{-2} \text{min}^{-1}$	$(1/C) * (1.4333)$	Average
cal cm^{-2}	$t * (1/C) * (0.02389)$	Total
$C = (\text{LI-COR calibration}) * 0.1$ $t = \text{datalogger execution interval in seconds}$		

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